

**Final Technical Report  
for  
NASA Grant NAG5-3171  
Polar Magnetic Field Experiment  
Principal Investigator: C. T. Russell  
03/01/96 – 03/31/99**

## **Accomplishments**

This grant covers the initial data reduction and analysis of the magnetic field measurements of the Polar spacecraft. At this writing data for the first three years of the mission have been processed and deposited in the key parameter database. These data are also available in a variety of time resolutions and coordinate systems via a webserver at UCLA that provides both plots and digital data. The flight software has twice been reprogrammed: once to remove a glitch in the data where there were rare collisions between commands in the central processing unit and once to provide burst mode data at 100 samples per second on a regular basis. The instrument continues to function as described in the instrument paper (1.1 in the bibliography attached below).

The early observations were compared with observations on the same field lines at lower altitudes (1.2). We find a similar distribution of currents as at low altitudes with similar magnitudes (1.3). Substorms also affect the orientation of the field high over the polar cap. Growth phase and expansion phase effects are seen (1.4). Around the polar cusp a broad area of depression of the field referenced to the Tsyganenko model is seen that we interpret as a difference in the shape of the magnetopause around the cusp from the shape assumed in the model (1.5). The cusp also has a sharp depression in the field strength where there is enhanced plasma.

The Polar magnetic measurements also proved to be most useful for testing the accuracy of MHD models (1.6, 1.11) and for comparing with more empirical models (1.7). Low altitude measurements also were found to be very sensitive to the currents in the ring current enabling us to develop a new technique to monitor it (1.8). Other investigations of the low altitude current systems showed them to be very sensitive to the north-south component of the magnetic field but rather less sensitive to the dynamic pressure (1.9). Similar studies at high altitudes revealed the sensitivity of the outer magnetosphere to high dynamic pressure and the north-south component of the IMF (1.10).

When the IMF is almost due northward reconnection of the IMF and the tail lobe magnetic field can occur above and behind the polar cusp. This important process can add solar wind plasma directly to closed magnetospheric field lines on the dayside of the Earth. J. W. Dungey had conjectured in 1963 that this mechanism could occur but it was not until 1998 that we were able to show this unambiguously by comparing observations with numerical models (1.11).

We also made important contributions to the study of waves and turbulence. Co-Investigator, Cindy Cattell, discovered that large amplitude parallel electric fields were moving

along the magnetic field lines near the edge of the plasma sheet (1.12). H. Laakso discovered that IMF directional changes could trigger waves in the magnetosphere (1.13). We also explored turbulence in the neighborhood of the magnetosheath-polar cusp interface by comparing Interball measurements with Polar (1.14).

We supported many studies by other Polar investigators. W. K. Peterson studied a FAST-POLAR conjunction (1.15). N. Maynard examined the convection pattern when the IMF was northward (1.16, 1.19). J. Chen with T. A. Fritz studied the possibility of energetic particles being accelerated in the polar cusp (1.17). E. Whipple used the trajectories of charged particles to study the magnetospheric electric field pattern (1.18). C. A. Cattell used the time separation of pulses on the two electric antennas to measure their velocity (1.20) and N. A. Tsyganenko completed a survey of the magnetic field in the inner magnetosphere (1.22).

We also continued to understand better the magnetic configuration of the magnetosphere using our own measurements. Graduate student X-W. Zhou showed how the polar cusp location varies with the tilt angle (1.21). C. T. Russell also showed how the magnetic field at high altitudes responds to a sudden change in the solar wind dynamic pressure (1.23) in an effort to explain why there was an abrupt change in the properties of the plasma when the pressure wave passed over Polar (1.24). These latter two papers have been accepted for publication.

In addition to these papers, numerous papers were presented at scientific meetings and at the ISTP meetings. These oral presentations are listed below but we do not repeat a description of each of their contents here. By and large their content is covered in the papers discussed above.

No patents or inventions were developed as a result of this grant. This work now continues under the auspices of grant NAG5-7721.

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